BASE CAMP PROTECTION AND SURVIVABILITY DEMONSTRATION PROGRAM

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ABSTRACT

Base camps and other forward deployed operating bases are highly vulnerable to conventional and asymmetric/terrorist attacks. The frequency of attacks against Allied Forces during Operations Enduring Freedom and Iraqi Freedom indicate current and future force deployments face an increased probability of such attacks. The high casualty rates and disruption to operations emphasize the need for enhanced protection of deployed U.S. Forces. Figure 1 is representative of the base camps our deployed Forces are currently occupying. The U.S. Army Engineer Research and Development Center (ERDC), Geotechnical and Structures Laboratory (GSL), is executing a 6.3-funded Base Camp Protection/Survivability (BCP/S) Demonstration Program. The purpose of this demonstration is to provide rapid transition of 6.2-funded research products to the warfighter for enhanced protection of base camps and forward operating bases. This effort is divided into several thrust areas including protection of bed down areas, enhancements to entry control points, protective upgrades to conventional construction, improved protective positions/bunkers, decision aids for physical security sensors, and base camp protection planning and assessment software. The demonstration Program is currently funded for execution in FY04-05. The purpose of this paper is to provide an overview of the force protection products demonstrated and transitioned to the warfighter in the USA ERDC BCP/S Demonstration Program and their contribution to the defensive posture of deployed U.S. Forces.

1. INTRODUCTION

In many parts of the world, Department of Defense (DOD) personnel are currently stationed in temporary facilities that provide only limited protection from terrorist and conventional attack. Large numbers of military personnel in Afghanistan and Iraq are located in expediently constructed temporary compounds or conventional structures not designed to withstand rocket attacks, mortar rounds, and the increasing threat of car bombs. Many of these facilities originally intended as temporary quarters have become semi-permanent with personnel continually exposed to insurgent attacks.

Fig. 1. Temporary base camps often do not offer adequate protection from terrorist attack.

The frequency and ferocity of attacks against Coalition Forces during Operations Enduring Freedom and Iraqi Freedom indicate that current and future force deployments will likely continue to face such threats. Figure 2 is representative of the threats being faced and had a caption as follows: "Masked insurgents stand by rockets ready to be launched, targeting an (sic) U.S. base, in Ramadi, Iraq (news - web sites), Tuesday Sept. 28, 2004. Fighting in the al-Anbar province, of which Ramadi remains one of the most troublesome spots, has taken the lives of several U.S. Marine Corps in the past few weeks. (AP Photo/Str)". The high casualty rates and disruption to operations emphasize the need for enhanced protection of deployed U.S. and Coalition Forces.

2. SOLUTIONS SOUGHT

The U.S. Army Engineer Research and Development Center (ERDC), Geotechnical and Structures Laboratory (GSL), Vicksburg, MS, is presently conducting a Base Camp Protection/Survivability (BCP/S) Demonstration Program. This Program is being conducted with the endorsement of the Army, Marine Corps, Navy, Air Force, and the Joint Staff and many of its products will be transitioned into the J-34 Joint Anti-Terrorism (JAT) Program.

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The BCP/S Demonstration Program is providing rapid transition of research products such as advanced materials, protective designs, physical security systems,

Fig. 2. Insurgents position rockets prior to attack. (AP Photo/Str).

and survivability planning and assessment software to the warfighter for enhanced protection of base camps and forward deployed operations. Force protection is a critical requirement from CENTCOM and the products of this research Program are being provided directly to the CENTCOM Joint Securities Directorate, J-8, and ARCENT, U.S. Army Rapid Equipping Force, U.S. Army TRADOC, IED Task Force, Counter Strike Task Force, as well as other DOD agencies for immediate use by the warfighter. The Program emphasizes lightweight and low-cost blast/ballistic protective measures against conventional weapons and terrorist threats. Results are providing improved protective measures, reduced logistics requirements, and enhanced force capabilities for our low-intensity conflicts and peacekeeping operations.

ERDC GSL has the lead responsibility for joint services research in the area of Survivability and Protective Structures and is uniquely qualified to execute this mission. ERDC has years of experience and expertise in research on blast effects on structures and blast mitigation techniques. ERDC has developed Antiterrorism Planner software, has access to in-house supercomputer facilities and an on-site Projectile Penetration Research Facility, and maintains the world's largest Research Centrifuge and one of the world's highest fidelity Blast Load Simulators (Figure 3). Applicable companion research efforts include the Joint Antiterrorism (JAT) Program Manager's Guide, Sensor Capability Research, and High Performance Materials Research. ERDC also has the ability to execute large scale explosive events at various test ranges as well as static and live fire detonation of small-arms, mortars, and rockets.

Fig. 3. ERDC's blast load simulator is one of many unique capabilities ERDC can apply to base camp protection/survivability research.

3. ROCKET, ARTILLERY, AND MORTAR (RAM) PROTECTION

Concentrations of troops and billeting areas are of special concern because of their high casualty potential and inherent lack of permanent protective measures in a forward and often fluid environment. Out of necessity, troop bed-down areas are generally "soft" and often include tents, trailers, and other expedient structures. Also, bed-down areas in many existing U.S. base camps are located in and around urban areas. Without the ability to control an adequate stand-off area beyond their perimeter, base camps – and particularly the bed-down areas – are vulnerable to asymmetric and terrorist attacks. This vulnerability is significantly increased by the density of personnel and soft nature of their living quarters, resulting in lucrative target areas for attack with fragmenting munitions (rockets and mortars). A significant survivability enhancement is the development of retrofit hardening and protective measures for shelter areas. However, due to the sheer number of structures involved and the square footage requirements, passive protection materials must be cost-effective and easy to construct in the theater of operations.

The BCP/S Demonstration Program has conducted multiple weapons effects experiments assessing protection against RAM threats. The objectives of these experiments were to evaluate potential pre-detonation material performance and fuze-membrane interaction and evaluate coupled performance of candidate pre-detonation materials and fragment shielding layers for a variety of mortar and rocket threats. Figure 4 shows a sequence of photos obtained during the evaluation of materials for the pre-detonation of rockets. Figure 5 shows a test configuration designed to evaluate pre-detonation materials coupled with a fragment shielding layer in a live-fire mortar environment. Additional experiments will be conducted before the end of the calendar year to support rapid fielding initiatives for RAM protection.

Fig. 4. Rocket pre-detonation sequence.

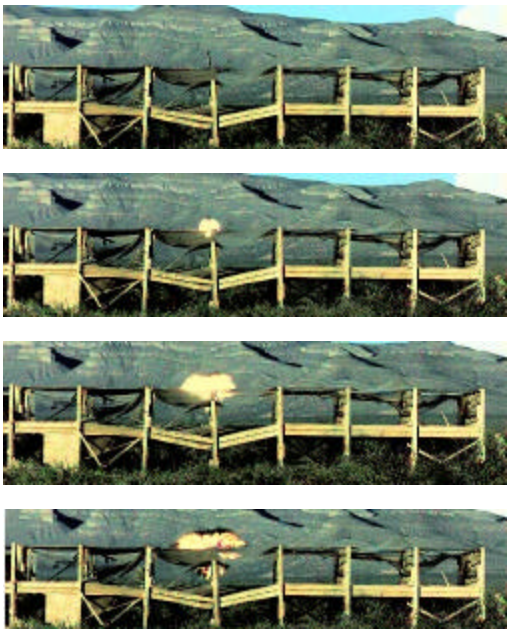

Fig. 5. Mortar pre-detonation sequence

Various combinations of materials and techniques are being investigated for use in protective positions that will provide increased protection against blast and fragmentation effects. Among these are compartmentalization techniques, expedient protective designs, modular concrete bunkers, and new lightweight blast/ballistic resistant materials. By adding effective blast resistant walls for compartmentalization within complexes of temporary structures, the potential for is greatly diminished. Figure 6 shows Hesco Bastion revetments used for compartmentalization around assets at, Ft. Polk, LA.

Fig. 6. Compartmentalization around Tactical Operations Center (TOC) assets at Joint Readiness Training Center (JRTC), Ft. Polk, LA.

Information already provided to troops in the field details the levels of protection provided by different types of protective materials and positions as well as details required for the construction of the positions. Designs for a family of protective positions ranging from fighting positions to observation posts utilizing Hesco Bastion materials have been developed. National Stock Numbers were established for the protective positions, bills of materials and construction details were developed, and training materials for the positions were deployed in OIF/OEF. Field expedient designs for protective structures have been developed for adding retrofit protection to containers, in both above and below-ground configurations. An above-ground bunker constructed with Hesco Bastion materials and an ISO container were evaluated during training exercises at Joint Readiness Training Center (JRTC), Fort Polk, LA (Figure 7).

Fig. 7. Troop evaluation of above ground ISO Container Bunker at JRTC, Ft. Polk, LA.

A modular protective concrete bunker was developed to provide a solution for threat protection that could be constructed in-theater. The modular nature of the bunker components allows multiple configurations and use in a variety of scenarios. The bunker was evaluated in large blast environments and static detonation testing against the blast and fragmentation of rockets and mortars. Figure 8 shows the testing of the modular concrete bunker against the blast and fragmentation of rockets and mortars.

Fig. 8. Weapons effects experiments on modular concrete bunker.

4. UPGRADE OF PROTECTION FOR CONVENTIONAL STRUCTURES

Un-reinforced conventional structures are often utilized for billeting troops and operational space. Lightweight materials, layering or sandwiching materials, spray-on or trowel-on polymers, and adding perimeter blast walls are some of the areas under study to address this situation.

Concrete masonry units (CMU), commonly referred to as concrete blocks, are the most common construction material in the world for exterior walls of conventional structures. While CMU provide adequate strength for conventional design loads, they do not meet minimum design standards mandated for blast protection of new and renovated facilities. One of the mo st dangerous aspects of blast response is debris hazard, defined as high-velocity fragments originating from walls, windows, furniture, etc. Retrofits for conventional structures have evolved from blast hardening through the addition of concrete or steel mass, to the application of lighter, more resilient and ductile materials. Recent ERDC research has focused on the use of elastomeric materials to mitigate debris hazards resulting from blast events. Ongoing wall retrofit tests are allowing researchers to evaluate the response of full scale building components to blast effects.

Fig. 9. Wall retrofits using trowel-on elastomers are subjected to full scale blast effects in experiments at Eglin AFB.

5. ENTRY CONTROL POINT (ECP) PROTECTION

The evaluation and full-scale field demonstration of designs, materials, and improvements for entry control points (EPC) are a major part of the BCP/S Demonstration Program. For example, recent attacks have shown that ECPs are likely targets for asymmetric attack with suicide bombers and vehicle borne improvised explosive devices (VBIED). Figure 10 shows a recent VBIED attack. To address this issue, the BCP/S Program is demonstrating ECP concepts, designs, and materials at the JRTC at Ft Polk, LA. The intent of this effort is to provide an actual ECP demonstration area that can be used to evaluate ECP configurations for effectiveness in meeting new CENTCOM standards for multi-layer protection. Multiple materials, available to deployed Forces, are being demonstrated in the JRTC evaluations.

Fig. 10. Recent VBIED attack.

Figure 11 shows the JRTC ECP demonstration site while under construction. Troops will be able to see numerous entry control concepts and how a properly designed ECP can effectively control vehicles and pedestrians while participating in pre-deployment training exercises.

Fig. 11 Entry control point demonstration site under construction at JRTC, Ft. Polk, LA.

6. PHYSICAL SECURITY SENSOR EVALUATION AND ASSESSMENT TOOLS

Traditional physical security measures employed at fixed installations are not normally available or necessarily effective in base camp applications. Sensor systems must be able to operate reliably at an early stage of base camp development when an intrusion detection capability must be established quickly under austere conditions. A thrust within this Program is the development and fielding of software tools to rapidly evaluate weather and terrain effects and to allow site-specific intrusion detection system sensor selection. Additionally, this Program is evaluating the use of existing unattended ground sensors (UGS) to provide early awareness of intruders, temporarily secure relocated perimeters, and add an additional layer of security. The UGS research will determine how to best detect approaching vehicles and personnel with emphasis on the smaller, quieter personnel target. Early detection increases the security force's options for response and supports the use of non-lethal means of deterrence. The physical security sensor tools development and demonstration efforts are being conducted by the ERDC Cold Regions Research Engineer Laboratory (CRREL) Hanover, NH.

The use of physical security sensor systems lowers the risk of base camp incursions only if the effectiveness of the sensor systems is not jeopardized by errors in their selection, placement, or operation. Vulnerabilities result when terrain, weather, system performance constraints, or detection zone features and maintenance are overlooked or ignored during the planning and implementation of sensor-based physical security. This problem is exacerbated for base camps because security must cover many configurations, ranging from forward operating bases to the equivalent of fixed facility installations. Tools that both guide sensor-based security design to attain lowered risk level and also adapt security measures to each stage in base camp evolution are needed.

This Program is developing tools for lowering the risk level at base camps through reducing the likelihood that factors compromising sensor-based security will be overlooked or ignored. The Weather Vulnerability Assessment Tool (WVAT), directed at avoidance of short-term heightened risk, will generate security alerts for vulnerabilities with security sensors arising from observed or forecast site conditions. The Force Protection Sensor Selector (FPSS) will assess a region of interest for weather and terrain effects on intrusion detection and automated video surveillance, consider mission and operational constraints on available security equipment, and rank equipment on the basis of the duration, frequency of occurrence, and severity of vulnerabilities. FPSS and WVAT are complementary approaches to ensuring effective sensor-based security: FPSS factors weather and terrain related vulnerabilities into the selection of sensors for deployment . WVAT alerts security personnel to potential changes in detection capabilities of sensors already installed at a site, while. The Security Options Decision Tree Tool (SODTT) will lead the user through the specification of security objectives, identification of constraints due to non-interference with mission, and consideration of possible security scenarios, leading to the use of FPSS for

guidance in equipment selection. These tools, together with sensor placement criteria, will enable the design of dynamic security measures that are suitable for a variety of base camp configurations and missions.

Fig. 12. Physical security sensor selection and assessment tools.

7. PROTECTION PLANNING FOR EXPEDITIONARY OPERATIONS

The BCP/S Demonstration Program is developing software tools for base camp survivability planning and assessment. The Simplified Survivability Assessment (SSA) Program was fielded in 2003 at the beginning of Operation Iraqi Freedom with engineers from the 101st Airborne Division. This software provides the capability for rapid survivability mission planning and assessment. The SSA is being enhanced under this Program with protective designs tailored for forward operating bases (Figure 13).

Fig. 13. Simplified Survivability Assessment software.

The Antiterrorism Planner (AT Planner) is being enhanced for greater functionality and ease of use in assessing structural vulnerability in forward facilities. The AT Planner allows the calculation of levels of protection for buildings and estimates of injuries and fatalities from wall and window flying debris resulting from large vehicle bombs. It is very effective in calculating the blast damage to structures and personnel and determining required safe standoff distances for various vehicle bomb scenarios. The AT Planner has been provided to AT/FP officers of U.S. III Corps and the U.S. Army Corps of Engineers Gulf Regions Division and is being used at locations in Iraq to include Camp Victory and Camp Anaconda. Data are being collected in full-scale experiments to validate protective upgrades for temporary and expedient structures and incorporated into the survivability planning and assessment capability of the AT Planner. Interfaces will be developed to allow base camp layouts to be easily imported into the Program to facilitate survivability planning and assessment. Figures 14 and 15 show example results from the AT Planner software.

This enhanced capability for base camps in AT Planner and enhancements to SSA will be transitioned to the warfighter as ERDC develops the Expeditionary Operations Module of the J-34 sponsored Joint Anti-Terrorism (JAT) Program Guide (Figure 16). In the summer of 2005 the process, tools (including the AT Planner enhanced for base camp survivability planning and assessment), and templates for developing an expeditionary operations anti-terrorism plan will be provided in Version 1.1 of the JAT Guide. Interim information is available in the JAT Guide under the heading "Expeditionary Operations" and includes AT manuals, fact sheets, protective designs, and general information on AT protective measures.

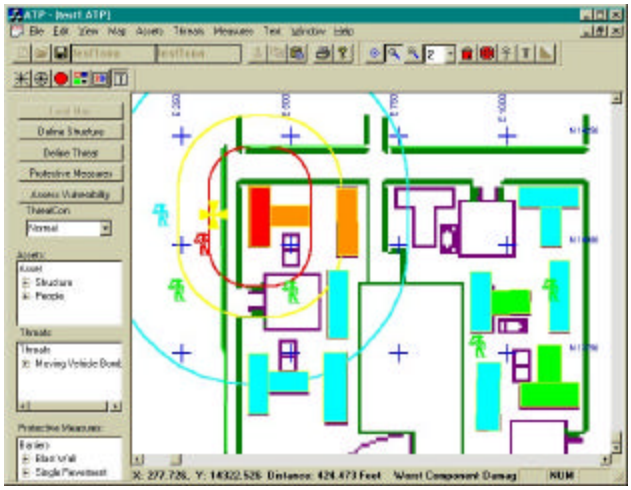

Fig. 14. AT Planner threat stand-off calculation output.

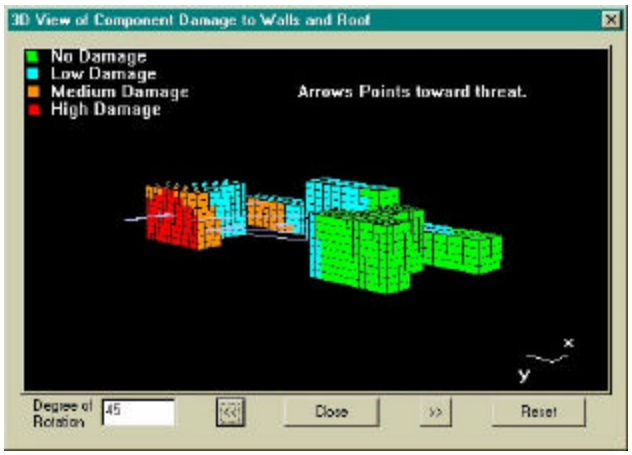

Fig. 15. AT Planner vulnerability assessment software output.

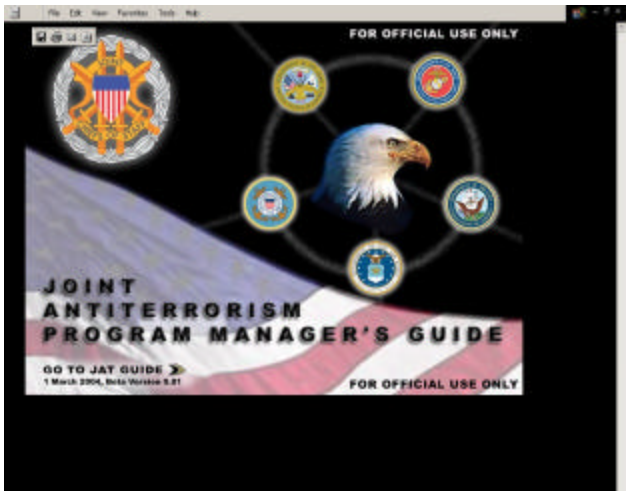

Fig. 16. Joint Antiterrorism Program Manager's Guide.

CONCLUSIONS

The BCP/S Demonstration Program is providing necessary products for improved protection for forward deployed DOD personnel and warfighters. Providing improved protection for base camps and other forward operating bases is one of the most critical issues currently being faced by deployed Forces.

ERDC continues to execute this Program with requirements being addressed from all services. Products are being transitioned rapidly to deployed units, the USACE Protective Design Center (PDC), the U.S. Air Force Research Laboratory (AFRL), Naval Facilities Engineering Command (NAVFAC), multiple U.S. Marine Corps Offices, and the Joint Security Directorate, CENTCOM. In the most recent efforts ERDC has partnered with ARCENT, the U.S. Army Counter Strike Task Force, Improvised Explosive Device Task Force, Rapid Equipping Force, Manuever Support Center, and TRADOC Futures Center to develop solutions for the Counter – Rocket, Artillery, and Mortar Initiative and other thrusts being addressed in the BCP/S Demonstration Program.

Our military will continue to face asymmetric threats for years to come. Improved capabilities to counter these threats with material solutions and survivability planning and assessment tools will be required for adequate protection of U.S. and Allied soldiers. Protection for our soldiers will require a holistic approach to the problem, including threat sensing, early warning, threat intercept and interdiction, counter-strike, passive physical protection, and integrated command and control. This effort is providing immediate products addressing the passive physical protection measures that are a key pillar in this holistic approach.

The BCP/S Demonstration Program is addressing the passive protection pillar through multiple thrust areas established by the Army and other services. One major thrust for the passive protection pillar is RAM protection. This incorporates measures for compartmentalization, pre-detonation materials for mortars and rockets, and fragment shielding layers for overhead cover and side wall protection. Protection measures and experiment designs are developed using analytical procedures for dynamic structural and material response and fragment penetration. Both laboratory and field experiments can then be used to validate the protective measures. Additional thrusts addressed in the passive protection pillar include improved entry control points, protection upgrades to conventional construction, expedient protective positions and design guidance, and survivability planning and assessment tools. Physical security sensor evaluation and assessment tools provide valuable guidance to assist the soldier in the selection and use of physical security sensors and will enhance the capability to sense the threat and have early warning.

Due to the immediate nature of the force protection issues being addressed protective measures are being developed with a balance between the incorporation of new developments in high performance materials and the optimum use of commonly available, low-cost construction materials. The goal of this Program is to provide the soldier with logistically and operationally feasible protective designs giving consideration to the severe constraints within forward theaters of operation.

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